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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/757,276	01/14/2004	Kevin L. Beaman	MI22-2475	4316
21567	7590	02/06/2006	EXAMINER	
WELLS ST. JOHN P.S. 601 W. FIRST AVENUE, SUITE 1300 SPOKANE, WA 99201			SMOOT, STEPHEN W	
			ART UNIT	PAPER NUMBER
			2813	

DATE MAILED: 02/06/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

EK

<b>Office Action Summary</b>	<b>Application No.</b> 10/757,276	<b>Applicant(s)</b> BEAMAN ET AL.	
	<b>Examiner</b> Stephen W. Smoot	<b>Art Unit</b> 2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

#### Status

- 1) ☒ Responsive to communication(s) filed on 18 November 2005.
- 2a) ☒ This action is **FINAL**.                      2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

#### Disposition of Claims

- 4) ☒ Claim(s) 36-41, 43-45 and 49-64 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 36-41, 43-45 and 49-64 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

#### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 14 January 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

#### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

#### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

## **DETAILED ACTION**

This Office action is in response to applicant's amendment filed on 18 November 2005.

### ***Terminal Disclaimer***

1. The terminal disclaimer filed on 18 November 2005 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of U.S. Patent No. 6,686,298 has been reviewed and is accepted. The terminal disclaimer has been recorded.

### ***Claim Rejections - 35 USC § 112***

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

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3. Claims 56-57, 59-60, 62-63 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claims contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time the application was filed, had possession of the claimed invention.

The originally filed disclosure does not provide support for the feature of changing the first energy state of the nitrogen atoms to a different second energy state before the step of exposing as claimed in newly added claims 56, 59, 62 (see lines 3-4). Newly added claims 57, 60, 63 are rejected under 35 U.S.C. 112, first paragraph, because they depend on claims 56, 59, 62, respectively.

### ***Claim Rejections - 35 USC § 102***

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

5. Claims 36-41, 43-45, 49-55 are rejected under 35 U.S.C. 102(e) as being anticipated by Holloway (US 6,040,249).

Referring to column 2, line 51 to column 3, line 9, Holloway discloses methods of nitriding an exposed surface of a gate oxide that is formed on a silicon substrate. The nitrogen is contained in a surface region of the gate oxide and is prevented from reaching a bottom region of the gate oxide (also see column 2, lines 9-15). In a first embodiment, the exposed gate oxide surface is nitrided with free nitrogen radicals that are remotely generated by microwave plasma. In a second embodiment, a DC bias is applied to the substrate in order to provide nitrogen ions to the exposed oxide layer. It is implied by the disclosure of Holloway that a bias is not applied to the substrate in the first embodiment, for which only nitrogen radicals are generated. After the gate oxide nitrogen radical surface treatment, a gate electrode is deposited. The gate electrode can be n-type or p-type (i.e. conductively doped) polysilicon (also see column 1, lines 19-30). Regarding the activated nitrogen species limitation of claim 36 (see lines 4-5) and the higher energy state limitation of claim 49 (see line 6), the disclosure of Noble et al. (US 6,450,116) is submitted as evidence to show that nitrogen radicals are believed to be neutral atoms that inherently occupy a high energy state (see column 8, lines 62-66).

These are all of the limitations set forth in claims 36, 39, 43, 49 of the applicant's invention.

Regarding claims 37-38, 40-41, 44-45, 50-55, Holloway further discloses that the gate oxide can be 4 nm (i.e. 40 angstroms) thick, that nitrogen should not be present within one monolayer (about 0.3 nm or 3 angstroms) of the interface with the substrate, that the acceptable depth range of nitrogen in the 4 nm (i.e. 40 angstroms) thick gate

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oxide is one monolayer (about 0.3 nm or 3 angstroms) to about 3.5 nm (i.e. 35 angstroms), and that the preferred depth from the gate oxide surface is 1 nm (i.e. 10 angstroms) (also see column 2, lines 8-20).

6. Claims 36-41, 49-55 are rejected under 35 U.S.C. 102(e) as being anticipated by Hattangady et al. (US 6,399,445 B1 – from applicant's IDS filed on 1-14-04).

Referring to Fig. 1 and column 3, lines 22-39, Hattangady et al. (US 6,399,445 B1) disclose a method for nitriding a silicon dioxide surface that includes forming a silicon dioxide layer (3) directly on a silicon substrate (1), impinging neutral nitrogen atoms on the exposed upper surface of the silicon dioxide layer (3) to form a nitrided layer (5), and forming a doped polysilicon gate electrode (7) directly on the nitrided layer (5). The neutral nitrogen atoms can be formed using charged atoms that are provided from a remote plasma generator (also see column 3, lines 40-60). The silicon dioxide layer (3) can have a thickness that ranges from 10 to 30 angstroms and the nitrided layer (5) can have a thickness that ranges from 5 to 10 angstroms. Regarding the activated nitrogen species limitation of claim 36 (see lines 4-5) and the higher energy state limitation of claim 49 (see line 6), the disclosure of Noble et al. (US 6,450,116) is submitted as evidence to show that nitrogen radicals are believed to be neutral atoms that inherently occupy a high energy state (see column 8, lines 62-66).

These are all of the limitations set forth in claims 36, 39, 49-52 of the applicant's invention.

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Regarding claims 37-38, 40-41, 55, when the silicon dioxide layer (3) is 30 angstroms and the nitrided layer (5) is 10 angstroms, the combined layer thickness is 40 angstroms.

Regarding claims 44, 53, the silicon dioxide layer (3) can be 10 angstroms thick.

Regarding claims 45, 54, the nitrided layer (5) can be 10 angstroms thick.

***Claim Rejections - 35 USC § 103***

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claims 56-57, 59-60, 62-63 are rejected under 35 U.S.C. 103(a) as being unpatentable over Holloway (US 6,040,249) as applied to claims 36, 43, 49 above, respectively, and further in view of Noble et al. (US 6,450,116 B1).

As shown above, Holloway anticipates claims 36, 43, 49 of the applicant's invention.

However, Holloway does not expressly teach or suggest that the nitrogen species change energy states before the exposing step, which is the further limitation to claims 36, 43, 49 as respectively set forth in claims 56, 59, 62 of the applicant's invention. More specifically, Holloway does not expressly teach or suggest that the

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nitrogen species change from a high energy state to a lower energy state, which is the further limitation to claims 56, 59, 62 as respectively set forth in claims 57, 60, 63 of the applicant's invention.

Referring to Fig. 3A, column 6, line 51 to column 9, line 15, and column 18, lines 1-15, Noble et al. teach a remote plasma apparatus for exposing a silicon dioxide layer on a silicon substrate to nitrogen radicals (i.e. neutral atoms occupying a high energy state – see column 8, lines 65-66). Noble et al. disclose the generation of plasma in a remote plasma applicator (300) that has a length of 12 inches and delivery of the plasma to a chamber (213) that includes the silicon substrate (100) via an inlet member (360) that has a length of 2.25 inches (see column 18, lines 1-15). The generated plasma includes nitrogen ions, nitrogen radicals, and electrons (see column 8, line 62 to column 9, line 15). The applicant's specification indicates that by separating the plasma from the substrate by a length of at least 12 inches, the highly activated nitrogen species will inherently relax before they reach the substrate (see page 8, line 19 to page 9, line 5). Further, the disclosure of Noble et al. indicates that the nitrogen radicals have a lifetime, which implies relaxation from a high energy state to a lower energy state (see column 16, line 63 to column 17, line 30).

Therefore it would have been obvious to a person of ordinary skill in the art at the time the invention was made to combine the teachings of Holloway and Noble et al. in order to use the plasma applicator of Noble et al. that features forming nitrogen radicals remotely at a distance of more than 12 inches from the substrate.



Noble et al. recognize that there are numerous advantages for using their remote plasma applicator to form nitrogen radicals for the subsequent nitridation of an oxide, which include the formation of an effective nitride barrier at the oxide surface, rapid formation of the barrier layer, and improved device performance (see column 20, lines 7-22).

9. Claims 58, 61, 64 are rejected under 35 U.S.C. 103(a) as being unpatentable over Holloway (US 6,040,249) as applied to claims 36, 43, 49 above, respectively, and further in view of Koyama et al. (US 5,981,366).

As shown above, Holloway anticipates claims 36, 43, 49 of the applicant's invention. However, Holloway lacks the further limitation to claims 36, 43, 49 as set forth in claims 58, 61, 64, respectively, which is forming a silicide layer over the conductively doped silicon. Koyama et al. teach a method of forming a gate electrode that includes first depositing a phosphorus doped polysilicon layer (5) and then depositing a tungsten silicide layer (6) (see Fig. 4 and column 3, lines 3-33).

Therefore it would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the teachings of Holloway by substituting the polysilicon/tungsten silicide bi-layer, as taught by Koyama et al., for the polysilicon gate electrode of Holloway. Koyama et al. recognize that the inclusion of tungsten silicide advantageously reduces the specific resistance of the gate electrode.

### ***Response to Arguments***

10. Applicant's arguments filed 18 November 2005 regarding Hattangady et al. (US 6,399,445 B1 – from applicant's IDS filed on 1-14-04) have been fully considered but they are not persuasive.

The applicant argues that Hattangady et al. lack the activated nitrogen species limitation of claim 36 (see lines 4-5) and also lack the higher energy state limitation of claim 49 (see line 6). However, as indicated above, these limitations are inherent characteristics of a nitrogen plasma as supported by the disclosure of Noble et al. (US 6,450,116), who indicate that nitrogen radicals are believed to be neutral atoms that inherently occupy a high energy state (see column 8, lines 62-66).

### ***Conclusion***

11. Applicant's amendment necessitated the new grounds of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not

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mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephen W. Smoot whose telephone number is 571-272-1698. The examiner can normally be reached on M-F (8:00 am to 4:30 pm).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

sws

  
**STEPHEN W. SMOOT**  
**PRIMARY EXAMINER**